11. Every endeavour should be made to instruct the people how mosquitoes live and have their being and how they are responsible for the spread of disease.

12. The staff proposed in Dr. Mhaskar's third scheme seems to me sufficient for the present needs of the Municipality bearing in mind their financial resources and the necessity for considerable expenditure in connection with measures mentioned above. This proposed additional staff should be amalgamated with the present staff of the Health Department and the duties of the various officers re-arranged so as to include among their other duties the periodical inspection of houses, wells, etc., with the object of detecting and removing mosquito breeding places and the instruction of the inhabitants in the life history of mosquitoes.

13. Although not relative to the present inquiry, I think it is necessary to draw attention to the large number of deaths which occur each year from plague in Karáchi and to suggest that measures to combat this disease are called for more urgently than for any other disease; it seems that familiarity with plague has bred some contempt for it.

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CHAPTER I.

YELLOW FEVER—INDIA'S FUTURE DANGER.

Section 1.

1. The Malaria Conference held in Bombay on November 10th and 17th, 1911, resolved that:—

"In view of the possibility of the importation of Yellow Fever in India, the Conference suggests the advisibility of a careful Stegomyia Survey and the education of the public in the matter of the destruction of domestic mosquitoes."

In accordance with this resolution the enquiry was started in Karáchi, as well as in other important ports of India having a large Eastern trade,—to prevent the Yellow Fever from getting an entrance through them.

2. Major E. F. Gordon Tucker, I. M. S., in a paper "Yellow Fever—India's Future Danger" read before the British Medical Association in June 1910 brought it prominently to notice, that the presence of *Stegomyia Fasciata* in a sea-port with trade communications with the East is a very serious matter. The essential facts in the epidemiology of Yellow Fever are, that it is a disease of sea-ports and especially affects shipping, by means of which it is conveyed to temperate climates at a great distance from the endemic areas. It affects the low-lying and insanitary areas of cities. It is a disease of warm climates, and latitude 22° North and South of the Equator roughly covers its area of maximum intensity—the key to the whole problem of epidemiology being the extra-corporeal host of the virus—Stegomyia Fasciata :—

"Considering 'the gross roads of the Pacific' of the future, Honolulu is the centre of the hemisphere which includes American continents, Japan, China and Malay Peninsula, Australia and New Zealand; and it is the central point of the direct route between Panama and Hongkong. It is hard to prognosticate as regards the direct trade between the endemic ports of Yellow Fever and India. India has of late been importing large quantities of sugar, which may in time come from Jamaica.

"The species *S. Fasciata* is widely distributed in the regions with which we are particularly concerned. As regards India, we have two of the three factors which permit Yellow Fever epidemics—(1) The *S. Fasciata* in abundance and (2) a complete non-immune population. The incubation period of Yellow Fever extends from 36 hours to 4 or 5 days. Another 3 days must be added to this when the diagnosis is doubtful. A case of Yellow Fever on a tramp steamer escaping detection will infect the Stegomyia on board, in whom the virus takes another 12 to 14 days to mature. So that in a period of 17 days, when the ordinary tramp steamer is approaching the Hawaiian group of islands, the virus will have matured in the mosquitoes and these can infect for 50 days after ingesting the virus. The *S. Fasciata* can make herself at home on steamers preferring warm spots such as cook's galley and engine room or in the hold containing cargoes of sugar. Efficient inspection at Honolulu will no doubt be a great protection to Hongkong and Shanghai; but the trade for Borneo and the adjacent islands and Malay Straits may utilize ports of call rather near the Equator, such as Christmas Island, where the inspection may not be so efficient."

YELLOW FEVER.

Section 2.

1. An acute specific, very fatal febrile disease, occurring within a peculiarly limited geographical area and is characterised by a definite course consisting of an initial stage of a Sthenic nature rapidly followed by such evidences of blood destruction, as black vomit, albuminuria, and jaundice.

CHART OF THE WORLD

ON MERCATORS PROJECTION.

Govt. Photozincco. Office, Poona, 1918.

2. *Geographical Distribution.*—Its geographical range is most restricted. Its centre is in the West Indies whence it spreads north to the United States and Mexico, south to Brazil, west to Central America and across the Isthmus of Panama to the Pacific Coast, along which it extends north to the Gulf of California and south to Peru. It has frequently been imported into Portugal and Spain and once into Italy, and cases have occurred in sea-port towns of France and England—Brest and Swansea as also in Mauritius, Marseilles and Gibralter.

3. *Epidemiology.*—Atmospheric temperature has a definite influence, requiring for its development in the intermediate host—*S. Fasciata*—a temperature of over 75° F., in which alone it flourishes and is active. Dampness favours it. Its favourable haunts are the sea-coast towns, the banks of rivers and flat delta country, rarely extending inwards; and when it does, it follows the lines of communication, *e. g.* railways, canals, etc.

4. *The incubation period* averages 3 to 5 days and has an extreme limit of 13 days. Occasionally the virus remains in the ship from the time she left port, infecting the crew several weeks after the ship has been at sea—thus giving a mistaken idea of a long incubation period.

5. *The Germ.*—The Yellow Fever patient is dangerous to his neighbours, only during the first 3 days of disease; after this he ceases to confer infection. One phase of the germ as it exists in blood is ultramicroscopic. The *S. Fasciata* acts as the intermediate host and is capable of giving the infection to non-immunes at any time subsequent to the 12th day of their Yellow Fever blood meal, and they retain their infective power for at least 57 days. The mosquito itself is capable of surviving for five months or over, after getting a feed of blood.

6. It has been noted that the *S. Fasciata* must first have a feed of blood before they lay their eggs and that the virus is capable of being passed on to the next generation by means of its eggs. Also that before the first egg-laying *S. Fasciata* is both diurnal and nocturnal but subsequently she is strictly *nocturnal*. Therefore a *S. Fasciata* biting during the day does not convey Yellow Fever. *S. Fasciata* is a good traveller (Gorgas) and an infected mosquito shipped by accident would suffice to set the whole tropical section of Eastern hemisphere—ablaze.

Litho Govt Photozinco Office, Poona. 1914.

CHAPTER II.

Brief Description of Karachi.

Section 1.

1. *Karáchi* the capital and the chief city of the province of Sind is situated nearly at the apex of the Arabian Sea in 24°·27′ N. Latitude and 66°·58′ E. Longitude. It is the third in importance of all the sea-ports of British India and is the natural outlet of the trade for Sind and Punjáb. It is the sea-board terminus of the great railway system of the North-West, as far as Peshawar in the north and round to Delhi in the east. The present importance of the port is due to its being the nearest point of disembarkation, being 200 miles nearer to Aden than Bombay, and may in future become the point of junction of the main lines of railway to Europe.

2. *Physical aspects.*—The area within municipal limits comprises nearly 74 square miles and includes large areas of waste and dry lands and rocky grounds, absolutely useless, and covered at certain seasons only by water. The aspect of the surrounding district is hilly excepting that bordering on the sea. Ranges of hills, lofty and barren, are found running from north to south with deep wide valleys between. After heavy falls of rain these afford good pasturage.

The area of Karáchi, *quâ* town, is much more limited, being only 5 square miles, and is in the shape of a triangle with its apex at the Custom House and the base formed by a line from the Cantonment Station to the Government gardens. Kiamari, with its long line of wharves, forms an entirely separate district, separated from the mainland by a narrow creek (the China creek), the village being two miles away from the city. Manora, Baba and Bhit are islands facing the long line of wharves and have constant communication with the mainland across the basin. On the north and the west a shallow break-water spreads out, through which runs the one river "Lyari" and a number of creeks connected with it. When heavy rain falls in the hills, the river flows with water; but this occurs only for a few days of the year and generally it is perfectly dry. The creeks are fringed with mangrove bushes, and drain the marshy ground and mud flats which are covered with water at high tide. The tidal waters of the creek have a scouring effect, and some of the mangrove swamps are almost entirely submerged twice a day.

3. *Hydrography.*—The canals of the district are all in the Indus Delta which extends from Ghizri to Ghar, 125 miles distant. The supply of water to the city is obtained from two wells on the Malir river 16 miles away, and is thence conducted by conduits into a distributing reservoir. The tanks in the city are all filled up. There are 271 wells in the city, none being found in the Civil Lines and at Kiamari which is the harbour proper. There are 230 wells in the Lyari division which is a suburban village extending beyond the Lyari river.

4. The town is not much above the mean sea-level, the greater part of it being from 5 to 7 feet above that level, while the Civil Lines are from 10 to 30 feet upwards. The marshy areas to the west of these and beyond Queen's Road are low-lying waste lands where the sea-water rushes in at spring tides and forms shallow pools.

5. *The vegetation* is characteristic of a rainless climate, dry atmosphere and a sandy soil impregnated with salts. Babul and milkbush are only seen and there are no jungles round about. There is little natural undergrowth. A great portion of the land on the east side—the Garden quarter—is under cultivation, a majority of them being market gardens.

Section 2.

1. *Climatic data.*—The climate of Karáchi resembles more nearly that of Bombay, in temperature, humidity and equability. The average mean annual temperature is 77·5° F.,

January being the coldest with an average mean temperature of 65·9° F., and June the warmest with an average of 87·6° F. The months from April to October show a mean maximum temperature of 89° F. and the months from November to March a mean maximum of 75° F. (Table 1—page 30).

2. *The rainfall* is slight and precarious and is not confined to the usual monsoon season of Bombay, *viz.*, June to October, but often happens in December and January. Nor is it ever a one long downpour. Excluding the last two abnormal years, the average annual rainfall varies from 5 to 7 inches. The rainfall being slight, only two seasons can be said to exist. The months of December and January are characterised by strong dust storms.

The following table shows the annual rainfall for the last 11 years:—

Year.	Number of rainy days.	Inches.	Year.	Number of rainy days.	Inches.
1902 ...	10	10·99	1908 ...	7	6·46
1903 ...	8	4·58	1909 ...	8	7·09
1904 ...	7	4·62	1910 ...	10	12·63
1905 ...	9	3·31	1911 ...	10	4·94
1906 ...	10	6·92	1912 ..	3	3·17
1907 ...	10	7·75			

An important work was carried out in the diversion of the main branch of the Lyari river, a stream which, though dry for a great part of the year, at times descends with an extraordinary velocity and volume. Some portion rushes into the town and remains for a fortnight after in pools till it dries.

3. *Humidity, etc.*—The atmosphere is generally dry from November to March, when the lowest relative humidity of 56 occurs in December. During November, December and January it remains fairly uniform till it reaches its maximum of 84 in July, when the monsoon winds begin blowing. The south-west winds prevail during 8 months of the year and this added to the low situation of the town and stagnant pools in the break-waters that surround it, make the climate humid and moist. The wind blows from west-south-west and its maximum velocity of 21 miles per hour is attained in June or July. By November the direction changes to North-East and then to North-West. The roads in the town lead straight from the harbour, and there are also very large open areas. The houses are mostly two-floored. All these combine to make the wind acutely felt in almost all parts of the town. (Tables 2 and 3).

Section 3.

1. *Population.*—The population of Karáchi according to the census of 1911 is 159,270, including 11,394 souls residing in Cantonment limits, showing an increase of 43,863 over that of 1901. This large number is very unevenly distributed over different areas. 27,810 are located in the small area of 217·24 acres between Bunder Road, Napier Road and Lyari River; the density of the population being 128·02 per acre. The Lyari quarter accounts for another 32,000 on an acreage of 919; the density being 34·79 per acre. The next two in point of congestion are the Runchore with 17,000 and Garden Quarter with 12,000. That is 3/5th of the total population is located in that portion of old Karáchi beyond Bunder Road. Kiamari and the Harbour account for only 8,000.

2. Karáchi, fifth in 1901 and fourth now among the towns of the Presidency, has increased 38 per cent. in spite of plague which has claimed nearly 25,000 victims. There are 39 industrial enterprises in the city, employing a total of 4,000 artisans. The most important are the Port Trust Engineering and the Tramway Company's shops. There are 5 metal working establishments, 8 grain mills, 3 quarries, 3 tanneries, besides a few printing presses, bulk oil companies, coach building and thread factories and one bone mill. The

city's phenomenal growth, much in excess of any other city in the province, is due to its activity as the outlet for the Punjab and Sind harvests, and the growth of its ocean-borne trade. (Tables IV and V.)

1. *The Maritime Trade of the Province of Sind.*—The trade dealt with in the attached figures is the sea-borne trade of the Chief Port of Karáchi with the foreign countries.

Section 4.

The total value of imports for the year ending 31st March 1912 rose to 1,671 lákhs, an increase of more than 18 per cent. on the year immediately preceding. Molasses, metals, kerosine oil, yarns and piece-goods account for the principal increases. The total imports in the articles of food and drink amounted to 317 lákhs, out of which *sugar* alone account for 256 lákhs, the following being the countries from whence it was imported:—Java, Mauritius, Austria, United Kingdom, Persia, Germany, Egypt and Hongkong.

The foreign export rose at the same time to 2,495 lákhs, showing an increase of over 9 per cent. on the preceding year. The principal increases occur under grain, cotton and hides. The total exports in articles of food and drink amounted to 1,520 lákhs.

Statement showing in tabular form the sea-borne foreign trade of Sind for the five years 1907-08 to 1911-12:—

	1907-08.	1908-09.	1909-10.	1910-11.	1911-12.
	Rs.	Rs.	Rs.	Rs.	Rs.
Total imports in lákhs ...	1,290	1,594	1,341	1,419	1,671
Total exports in lákhs ...	1,825	869	2,241	2,251	2,495

2. The amount of foreign shipping entering this port during 1911-12 was 960,000 tons representing 567 vessels and that clearing was 1,100,000 tons representing 607 vessels. Among the steamers which entered this port were in addition to the large number of British ones—German, Austrian, Norwegian, Greek, Swedish, etc.

3. The total trade with the East amounts to 223 lákhs, Java leading an easy first. The following countries also contribute:—The Malay Straits, Australia, Hongkong and China, Japan, Borneo, Phillipines, Pacific Coast of the United States of America and Mexico.

The coasting trade carried on by native sailing crafts is not negligible and includes most of the ports on the west coast of India.

1. *Municipal Administration.*—The Municipality is constituted under the Bombay Act of 1901. At the head of the Municipal Administration of the city is the Municipal Corporation and its managing committee. The Corporation is composed of 36, made up of 24 elected and 12 nominated Councillors. During the year 4 were officials and 32 non-officials or 11 Europeans and 25 Indians.

Section 5.

With the Corporation lies the power of the purse, and under the Act it is incumbent upon it to provide for the execution and maintenance of drainage, water-works, conservancy, reclamation of unhealthy localities, birth and death registration, measures for checking and preventing the spread of disease, maintenance and regulation of markets and slaughter-houses, and has powers to control public streets, primary schools, vaccination, public hospitals and dispensaries.

The entire executive is vested in the Chief Officer, who is also the Chief Engineer, and under him are the Engineer and the Health Officer. The revenue of the Corporation is obtained from a tax on houses, lands, town duties and octroi dues, wheel-tax, conservancy and water-rates vaccination fees.

The total income for 1911-12 was Rs. 16,33,109, the incidence of taxation being Rs. 5-9-11 and the incidence of income Rs. 11-10-0. The total expenditure in the same period was Rs. 18,59,314-10-0.

2. *Sanitation.*—The Public Health Department of the city is under the control of the Health Officer assisted by one Chief Inspector and four Sanitary Inspectors. For administrative purposes the city is divided into four divisions, one in charge of each Inspector. They are responsible both for conservancy and sanitary works in their respective divisions. Each of them are in turn assisted by Sub-Inspectors in charge of scavenging and halalcore service.

The Inspector is a man of experience only and no qualifications. During the previous year, three coolies and one mukadum under an Inspector were told off to abolish or disinfect the breeding places of mosquitoes in Civil Lines and Frere town, with questionable results. The cantonment has a separate mosquito brigade.

The following is the staff engaged for the work in the city :—

1 Chief Inspector.	27 Mukadums.
4 Inspectors.	5 Trip checkers.
8 Sub-Inspectors in charge of scavenging.	226 Halalcores.
6 Sub-Inspectors in charge of halalcore.	270 Sweepers, coolies, etc.

During the year 1911-12 Rs. 73,488 were spent in Public Health Department, Rs. 29,125 on hospitals and dispensaries, and Rs. 10,482 on plague and cholera precautions.

3. *Water-supply.*—The water-supply is excellent in quality, but insufficient in quantity. The outlying quarters are practically dependent on wells for their water-supply. The wells at Málir and Dumelotte provide the required supply at Karáchi. The domestic consumption of water per head works out at 14·4 gallons per day. In some places where the supply is good it is about 20 gallons per day, but in other places it does not exceed 5 gallons. The pressure is very low, necessitating the use of hand-pumps and cisterns in certain houses, while the rest, store it as they can in small receptacles. Most of the houses have a public stand-pipe in common, from which they have to fetch it, and the flow from these pipes is often intermittent. The capital expenditure incurred so far has been Rs. 18,54,880.

4. *Drainage.*—The whole of the city, except the Civil Lines, Kiamâri and the Lyári suburb, is drained on Shone's ejector system and gravitating drains. There are 13 of these ejectors at work. The quantity of the sewage is dealt with at the sewage-farm, two and half miles from the city and gives good satisfaction. The Civil Lines and Kiamári are supplied with catch-water pits, one or more for each house, from which the foul water is regularly carted away. The Lyári cannot even boast of these, and the waste water is somehow let out of the house and allowed to dry. The drainage system has not been extended to out-lying quarters, because of the great distances from house to house. The capital expenditure on drainage works amounts to Rs. 18,76,790.

1. *Vital statistics.*—The following table gives the recorded number of deaths against recorded plague mortality, male and female deaths, and the death-rate of each :— Section 6.

Year.	Total plague mortality.	Total number of deaths.	Death-rate per 1,000.	Total number of male deaths.	Male population.	Death-rate per 1,000.	Female deaths.	Female population.
1906-07	2,885	6,283	57·83	3,355	62,779	54·07	2,888	45,865
1907-08	2,380	5,425	49·93	2,905	...	46·27	2,52[illegible]	...
1908-09	2,547	5,946	54·72	3,287	...	52·35	2,659	...
1909-10	2,069	5,168	47·56	2,863	...	45·60	2,305	...
1910-11	1,681	5,316	35·94	2,935	88,056	33·33	2,591	59,820
1911-12	2,768	6,588	54·55	3,638	...	41·31	2,950	...

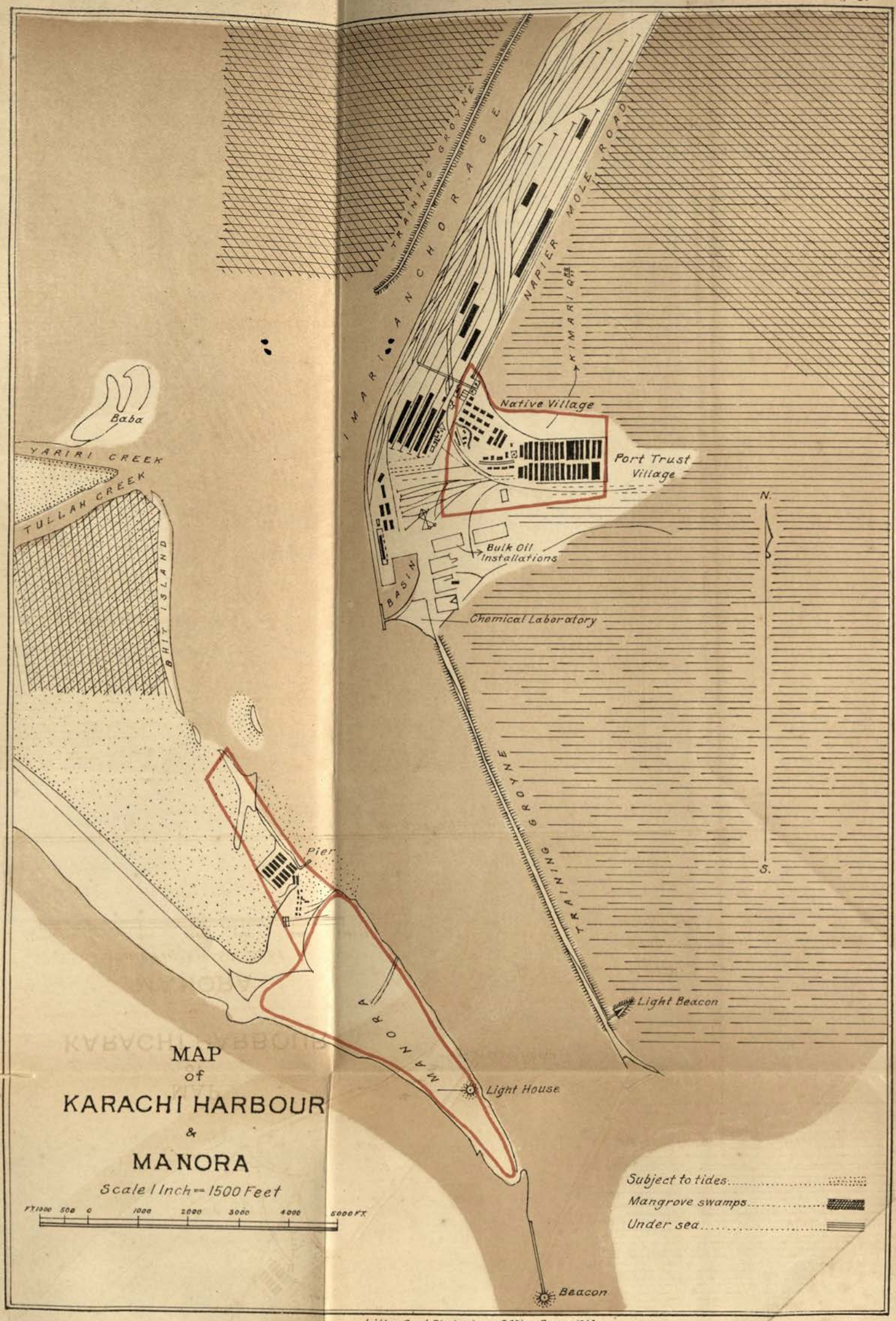
Deducting the recorded plague mortality from the total number of deaths, the true death-rate is 24·58 per mille for 1910-11 and 28·83 for 1911-12.

The following return gives the total deaths recorded under different headings with the calculated death-rate against each :—

Causes of death.	1911-12.		1910-11.		1909-10.	
	Number of deaths.	Death-rate per mille.	Number of deaths.	Death-rate per mille.	Number of deaths.	Death-rate per mille.
Fever ...	828	5·64	668	4·51	696	6·40
Small-pox ...	11	0·07	24	0·16	12	0·11
Cholera ...	9	0·06	38	0·35	...	...
Accidents ...	31	2·20	23	0·15	20	0·18
Stomach and bowel complaints ...	123	0·83	83	0·56	88	0·80
Plague ...	2,768	18·71	1,681	11·36	2,069	19·04
Other causes ...	2,818	19·05	2,799	18·92	2,283	21·01

The total number of births (exclusive of still-born) recorded in 1910-11 was 6,553 and the birth-rate is 52·89 per mille. The infant mortality for the same period being 225 per 1,000 infants born :—

Year.	Number of births.	Birth-rate per 1,000 of census population.	Census population.
1906-07	5,432	49·99	108,654
1907-08	6,070	55,87	...
1908-09	6,336	58·13	...
1909-10	6,083	55·99	...
1910-11	6,553	44·31	147,876
1911-12	6,279	42·46	...



Litho: Govt. Photozinco: Office, Poona, 1914.

CHAPTER III.

The Mosquitoes of Karachi.

The present survey was started about the 27th of August 1912 and includes a period of nearly six months. The order of examination was—The Civil Lines and Frere Town, Cantonment limits, Kiamári and Harbour, Manora, Baba and Bhit islands; then all the portion to the north of Bunder Road and last of all to the south of it. There were no rains during the period. The investigation included the survey of all the Culicid Fauna, but for purposes of this report, that of Stegomyia Fasciata (S. F.) will be treated separately.

The method of investigation was to examine all possible collections of water for larvæ and hatch them out in the Laboratory. A net of muslin was always used and passed round the edges of a tank; or the contents of a gharra were emptied through it, and the washing of the inverted net was followed as a routine measure. For wells a similar net was let down by means of a rope.

Section 1.

Breeding places.—A detailed consideration of all the breeding places met with during the survey, indicated that the vast majority of them are artificial, and differ with the class of people residing in the locality.

1. *The Harbour and Kiamári.*—The railway occupies a good deal of space on Kiamári and in connection with these there are a number of offices, godowns and bulk-oil installations. There are no docks, but a long line of wharves extends from one end to the other. The whole of the area is $1\frac{1}{4}$ square miles. A village built on model lines by the Port Trust forms a small part only of Kiamári.

(*a*) Of the permanent breeding places—there were masonry tanks for garden and other purposes, stand-pipes and the drains from these; and in the village 4 cattle troughs and cess pits to every house, imperfectly covered by wooden boards. There are no wells; excluding the cess pits and drains there are not more than 125 of these. Along the line of wharves and in harbour limits, the total number of permanent breeding places is 17, excluding the big tanks in connection with the steam power-house. Disused troughs, tinpots and holes in the machinery in the harbour were all dry.

I.—S. Fasciata were found in none of these except in six wooden tubs which are semi-permanent fixtures.

II.—Anophelines in three garden tanks and the water-logged areas about them.

III.—Culex found only in cess pits and 2 cattle troughs.

(*b*) Of the temporary breeding places are the gharras, *i. e.*, earthen drinking water-pots, antiformicas and tubs.

I.—S. Fasciata were found in 30 per cent. of the houses in the village.

2. Manora differs from the above. There are 7 wells about 12 feet deep which contain brackish water; 4 tanks of 30 feet diameter hold the telegraph cables, and though cleaned every eight days, were still found to harbour larvæ of A. Rossi. The water-supply is limited, and is brought over from across the harbour and stored in mosquito-proof cisterns. There are no garden tanks and the cess pits were free from any kind of larvæ:—

I.—S. Fasciata found only in gharras of four bungalows on the south side while the servants' quarter on the north side showed them as usual.

II.—Anophelines—in 3 wells and 4 telegraph tanks.

III.—Culex in few cess pits on the south side.

3. *Baba and Bhit Islands* are fishing places. There are no permanent breeding places here, except the west shore which is an extensive mangrove swamp affected by the tide twice a day.

I.—S. Fasciata found in gharras.

II and III.—Anophelines and Culex, *nil.*

4. *Shipping.*—The native barges on the native jetty and Ghas Bunder are of three kinds:—(1) those plying on the coast of Sind are light in structure and have a small tub or two for their water-supply; (2) those that ply between the adjacent coast-ports of Cutch and Mandvi and Veraval are somewhat heavily built and carry small casks sufficient to carry a supply for 8 days at the most; (3) are vessels coming from over long distances, *i. e.*, Malábár, Ceylon and Persian Gulf; these carry well-like wooden casks over 12 feet deep and had a narrow opening on top with a very badly fitting cover. The water carried in these was taken up at the initial port of call.

I.—S. Fasciata were found in (1) but with difficulty in some of those of (2), while all attempts to examine those of (3) were futile, because of the nature of the cask and the small hole on top.

The bilge water in not one, showed any kind of larvæ. This water was very foul from being mixed up with all kinds of stuff, and often emitted a hydrogen-sulphide odour.

III.—Culex, *nil.*

No other species of Stegomyia was found.

The city has been divided into 22 quarters for the purposes of the Municipality. For the better elucidation of the breeding places and further to facilitate the work of prevention, I have grouped the several quarters into three parts A, B and C. Each of these has several characters in common and stand out as distinct types from the rest (*viz.* Table IV-A).

Group A.

1. The Civil Lines.
2. Frere Town, etc.
3. Railway and Queen's Road.
4. Serai.
5. Rambagh.
6. Preedy.
7. Garden.
8. Ghizree.

Group B.

9. Old Town.
10. Napier.
11. Market.
12. Bunder.
13. Jail.
14. Runchore.
15. Ramswami.
16. Soldier Bazar.
17. Sadar Bazar.

Group C.

18. Lyári.
19. Machi Meani.
20. Kiamári.
21. Manora, Baba and Bhit.
22. Shamspir, etc.

Group A is characterised by well-to-do residents having houses with gardens and big compounds, out-houses and stables.

5. In the European quarter, *i. e.*, the Civil Lines, Frere Town Railway and Queen's Road as also the portion included within Cantonment limits, masonry garden tanks and mud channels or brick-work channels from these to various parts of the garden and catch water pits by far predominate. There are no wells and no municipal drainage. There is an extensive area of low marshy land near the road to Clifton, and another to the west of the Commissioner's compound; these are very sparsely covered with low bushes and weeds and show incrustation of salt on the surface. The effect of the spring-tides is felt here; the water stagnates and the puddles, which are shaded by weeds, etc., harboured numerous larvæ of anophelines in September. Latterly they were

MAP No. 4

LITHO. GOVT. PHOTOZINCO. OFFICE., POONA, 1914

found entirely free of these. There are only 31 cisterns to which the water is pumped up, 2 floral fountains and 3 cattle troughs and 556 garden tanks.

I.—S. Fasciata were found in only 4 garden tanks. These were near the out-houses, were small and shaded and had slimy walls and the water in them almost clear and very little disturbed. S. Fasciata were found in none else.

II.—Anophelines were found in over 60 garden tanks and tubs and in garden drains (which are not counted) of about 40 houses; in both the fountains, in 2 manure tanks, and disused cess pit (A Stephensi). In the marshes they were found in 4 places, well-shaded by weeds.

III.—Culex in 20 per cent. of the cess pits and in some garden tanks and water-logged areas in gardens and stable runnings.

(*b*) In addition to these permanent breeding places, the following are the temporary ones:—gharras, antiformicas (*i. e.*, shallow vessels, containing water placed under tables, etc., to prevent ants from ascending), flower pots, tubs, soda cooling chatties, exhaust the whole list.

I.—S. Fasciata were found in connection with 30 per cent. of the houses—the out-houses as well as the main building contributing equally. They formed as it were the index of the negligence of the servants.

II and III.—Anophelines and Culex, *nil.*

The whole of the foreshore south of the Queen's Road is marshy and covered by mangrove swamps—an area of about 2 square miles. The effect of spring tides only is felt which leaves shallow pools in its midst. The nearest house is a quarter of a mile away. Except one small place near the boat house, which showed A. Stephensi, Rossi and Culex, the whole area was free of any for the last three months. The temperature of the water never went above 30° c. One railway drain opening in this area was infested nearly in all its course.

6. Rambagh and Preedy are reproductions on a smaller scale of the Civil Lines, and the nature of the permanent as well as temporary breeding places is much the same. There are 14 wells of which 2 showed both Culex and Anopheles and 10 Culex alone. Most of these wells are brackish and no S. Fasciata were found in these.

I.—S. Fasciata were found in 10 per cent. of the houses in gharras and antiformicas.

II.—Anophelines in 16 garden tanks and drains.

III.—Culex as usual.

The Serai quarter is almost wholly composed of big godowns each of them with an extensive court-yard and a small block for offices and out-houses. There are 8 wells, all of which showed Culex.

I.—S. Fasciata were found in 4 per cent. of the houses.

7. The garden quater is intermediate in character between the Civil Lines and old town. There are big court-yards to several of the houses which are converted into cattle-yards, and further eastward into gardens. The wells here number 146 and are mostly brackish. Garden tanks, cisterns, cattle troughs and fountains form the permanent breeding places. The cattle-yards are very badly kept, the ground is soaked with urine and dung; no good care is taken to remove these, thus causing an abominable stench and apest of flies.

8. All the quarters in group B can be considered as a whole. Portions of it are densely crowded; there are no gardens except the Municipal ones. The water-supply is generous to most of the houses though those of the poor have, as usual, a stand-pipe in common to a number of houses. The area is well drained and some houses have water-closets in them and the cisterns of galvanized iron on top, to which the water is pumped. The cisterns serve to

store water for the closets. None of them were found to be used for drinking purposes. The covers to these were almost always bad and the water in them dirty. The wells to the number of 77 in this part are unevenly distributed, a majority of them being on the Garden quarter side and Runchore. They are narrow, deep and dark, are badly situated and badly kept. Nearly a half of these are in mosques or temples. Most of the wells are brackish and are used for washing and for animals.

The total number of breeding places added to those of Garden quarter are—223 wells, 1,386 garden tanks and masonry tanks, in mosques used for religious purposes, 128 cisterns, 71 cattle troughs and 74 floral fountains, 9 manure tanks :—

i. *S. Fasciata* found in 11 wells, of which 4 are brackish, 2 in a cowshed and 2 of tubs placed one on top of another. These are all small and shallow.

7 Garden tanks, 8 garden drains, 2 of which were far away from the house, were surrounded by bushes and were water-logged.

1 Floral fountains, 3 cattle-troughs, 15 cess pits, 7 of which were connected with the kitchen and 2 in out of use houses.

ii. *Anophelines* in 27 wells, 87 garden tanks, 86 garden drains, 4 fountains, no cattle troughs and 2 manure tanks, 5 catch-water pits (*A. Stephensi*).

iii. *Culex* were uniformly distributed in every other house.

(*b*) Of the temporary breeding places are the gharras, tubs, wooden and iron antiformicas, soda cooling chatties, etc :—

i. *S. Fasciata* were found in 4 per cent. of the houses.

ii. *Anophelines* nil.

iii. *Culex* almost negligible.

9. The Lyari suburb extends beyond the river Lyari and has almost wholly a working class population. There is no drainage and in most cases not even catch-water pits; the dirty water is allowed to flow out somehow and dry in the open spaces between houses. The houses are mere huts and sheds, the water supply is very limited and residents rely mostly on wells—268 in number; They are brackish, kutcha built, and sometimes so shallow that the sides were formed of tubs, two or three of which were placed one on top of another, with the bottoms knocked off. The sewage easily gains access to these and the water is in many cases exceedingly foul. There are in addition 37 large masonry water-tanks of a cubic capacity off about 15 cubit feet and are used for the storage of drinking water, etc., as a common supply to several houses. The covers are wooden boards and in all cases very badly fitted.

i. *S. Fasciata* found in 6 wells, 2 were built of tubs and 4 kutcha; all were brackish.

ii. *Anophelines* in 28 water tanks, *i. e.*, over 60 per cent., and in the bed of the river Lyari where the tide water has access to it.

iii. *Culex* in about 180 wells which were all foul and brackish, as also in some cesspits and in the bed of Lyari.

(*b*) Of the temporary breeding places are the gharras only.

i. *S. Fasciata* found in 40 per cent. of the houses. (The wells of the tanneries and wool-washing are not included in this list.)

SUMMARY.—(*a*) Summarising the total number of breeding places, the following conclusions are arrived at :— Section 2.

i. *S. Fasciata.*—Out of the total of 461 wells, excluding those of tanneries and wool washing company's, 17 were infected, *i. e.*, about 4 per cent. The wells had no points of similarity; they were of all sizes and depths, 4 were absolutely brackish and 6 contaminated

by filth and sewage from cattleyards and not more than 20 yards away from the nearest house, which in every case showed larvae of same, either in gharras or tubs. Of the 2,273 garden tanks only 11 were infected. The water in all of them was discoloured by decaying vegetable matter, but was in no case foul. Also of the total 116 cattle troughs and 80 floral fountains only 3 were infected.

(*b*) Of the temporary breeding places, gharras, especially those which were too big to be handled by one person, showed them. Tubs come next in order of number, but it must be remembered that these are infinitely less than the number of gharras. They were also found in 3 iron tubs only; also in soda cooling chatties, etc., and fire buckets.

(*c*) The *S. Fasciata* larvæ were found almost always by themselves. In 26 cases they found in association with *C. Fatigans* or *C. Concolor*, once with *A. Rossi* and four times with *A. Stephensi*.

ii. *Anophelines.*—(*a*) *A. Stephensi* have a distribution co-extensive with that of *A. Rossi* and their total number of breeding places is extremely limited. These will be considered together, as in many cases they overlap. Out of 461 wells they were found in 34, *i. e.*, about 8 per cent.; some of these were brackish and those at Manora are like seawater and contained *Rossi*. In 189 garden tanks, etc., out of 2,273, *i. e.*, in 9 per cent. in 4 garden tubs and in 6 out of 80 fountains and none in cattle troughs. The garden drains are not counted in this list as when found in one place they could be picked up throughout the whole length. They were found in five catch water pits and curiously enough in two very foul decomposing manure tanks. They were absent from nearly the whole of the marshy area and mangrove swamps except in one place whrere there was back-water, and in the railway drain they could be picked up in myriads. Taking their distribution as a whole they are not found in more than 8 per cent. of the total number of possible breeding places, the actual number in which they were found being a little less than 275.

(*b*) They were not found in any of the temporary breeding places.

iii. *Culex.*—The larvæ are found in the cesspits and drains in enormous numbers, breeding readily in foul water, and a stinking decomposing mass and faecal contamination are no debar. They were found in sweet and brackish well waters and also in the sea-water in marshes and mangrove swamps.

Out of the total of 513 wells including those of tanneries, 217, *i. e.*, 45% were infested; in 20% of the garden and the other tanks; in nearly all cattle troughs and public fountains of the city and in some of the cisterns on tops of houses, especially those in Lyari. Others of their breeding places are garden tubs and drains, manure tanks, stable runnings, fire buckets, pools of water near stand-pipes, cattle yards, etc.

(*c*) They were 26 times in association with *S. Fasciata*, 22 times with *A. Stephensi* and 27 times with *A. Rossi*.

B.—Distribution by Locality.

i. *S. Fasciata.*—An analyses of all the above shows that as things are at present, the Lyari and Civil Lines are most infested. The Garden quarter, Kiamari old town, etc., of group B and Rambagh and Serai come next in order of descending preponderance, but the first two are by far the worst. Their prevalence is an index of the negligence of people.

ii. *Anophelines.*—The Garden quarter is the most infested, then come the Civil Lines, Manora and Lyari. The rest show a specimen here and there. Those houses which have water-logged gardens, like the Madrasah in Serai, can be said to be their exclusive haunts.

iii. The *Culex* has a universal distribution, but the Lyari is the worst. The *Culex* and the flies are equal pests of Karáchi.

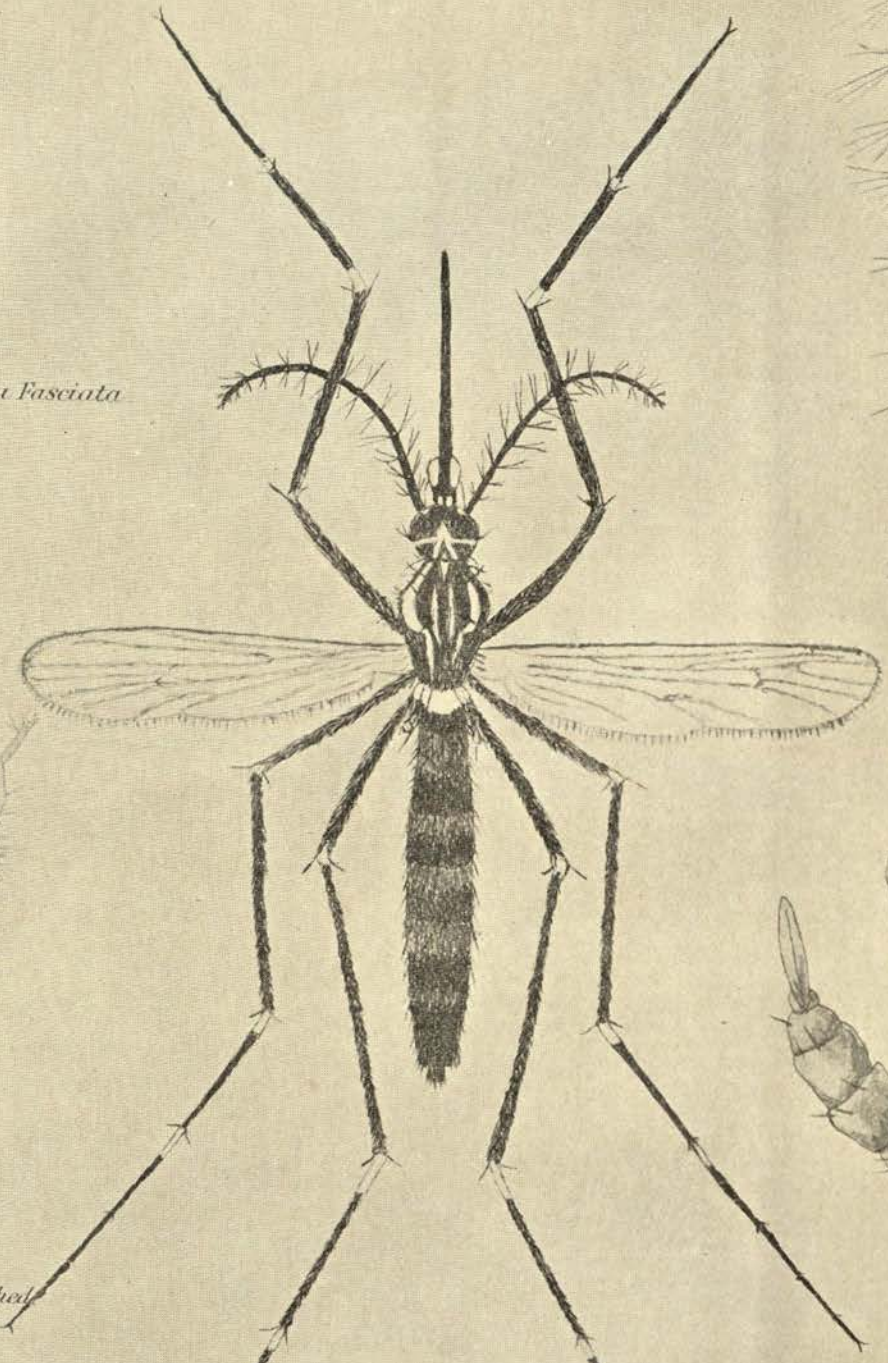
The following table gives the percentage distribution of each of the three in different localities. The percentages are deduced from the ratio of the actual number of breeding places to the possible ones of each class.

		i. S. Fasciata.	ii. Anophelines.	iii. Culex.
Group A.	Civil Lines and Frere town ...	... 30%	15%	20%
	Rambagh, Preedy and Serai ...	... 10%	6%	20%
	Garden			
Group B.	Lyari	... 4%	11%	20%
Group C.	Machi Meani	... 40%	9%	20%
	Kiamari and Harbour ...	... 30%	3%	40%

STEGOMYIA FASCIATA

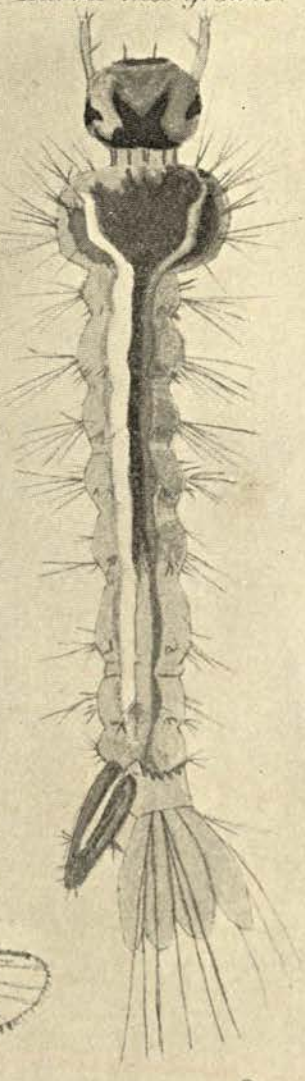
Egg of Stegomyia Fasciata

60



Adult Stegomyia Fasciata

30



Larva full-grown 30

Larva newly hatched

30

Pupa

30

CHAPTER IV.

THE MOSQUITOES OF KARACHI—*continued.*

The Mosquitoes of Karáchi.—The Culicid Fauna of Karáchi is very limited. The different species met with are:—

Section 1.

Culicines.

Stegomyiata Fasciata
Culex Fatigans
Culex Concolor
Culex Taeniorhynchus
Theobaldia Spathiapalpis.

Anophelines.

Nyssomyzomyia Rossi
Neocellia Stephensi
Cellia Pulcherima.

By far the commonest is *Culex Fatigans* and was found everywhere. The *S. Fasciata* came in next in extent of distribution, and each of these were severally proportionate to the permanent and temporary breeding places of the locality respectively.

Stegomyia Fasciata.

Section 2.

1. The genus *Stegomyia* is characterised by the head and scuttellum being entirely clothed with flat scales. *S. Fasciata* is the only species found in Karáchi. It is essentially a domestic mosquito living and breeding in the immediate neighbourhood of houses. It adapts itself readily to all sorts of conditions, provided the water is stagnant. It is pre-eminently a chatty breeding mosquito here, even clean and new chatties with clean water being sometimes found full of them. It cannot possibly be the odour of baked moist earth that attracts them most, because in Kumbarwadda, *i. e.*, the potters' quarter, where chatties are baked or made, their larval and adult population differed in no respect from any other similar quarter, and perhaps it was less still. It does not breed by preference in dirty or foul water, but can adapt itself readily under necessity to all sorts and conditions of life, *e. g.*, wells, garden tanks, tubs smeared with coal tar, cess-pits, etc. Their presence in cess-pits can only be accounted for by their being transferred from an original receptacle, as when this cess-pit water was bottled, they died either from development of foul gases or a thick film of fungus on surface of water.

2. *Larvæ.*—The larvæ are somewhat elongate with rudimentary antennae and a short stout syphon. They are of a creamy white colour and darken later to a pale brown tinge, when they are about to change into pupae. The intestinal canal can always be made out by the naked eye as a dark line in the body. Their movements are sluggish and wriggling, and they pass a greater part of their time in browsing at the bottom. At the surface they hang limp down almost vertical, or go round and round the receptacle by wormlike movements. The size of the larva differs according to the quantity and nature of food available, and the greater of it there was, they became plump and opaque white, suggesting almost a fungus growth on their body. I am inclined to believe that they live entirely on dead organic matter—vegetable or animal—and were never observed to touch unicellular living organisms running even near their mouth-brushes. Active Vorticella were often seen living and attached to a part of their body. No definite period can be assigned to the length of their larval life. In the Laboratory when abundant food was supplied they turned into Nymphae on the 9th day at the earliest (from the time of the hatching of eggs) to the 15th. They were observed to moult twice. Under conditions found outside, the shortest time has been two weeks and the longest nine weeks; and that, while some of the same breed, attained maturity earlier, that of others was considerably retarded. Another thing noticed was that the size of the larva in no way limited that of the adult Imago—small mosquitoes hatching out of even big larvæ and *vice versâ*.

3. *The Nymphae* are not so dark as those of *C. Fatigans*; the trumpets are expanded and broadly triangular in shape. They hatch out within 2 to 4 days invariably and never more.

4. *The Imago* varies in size from 2·5 to 4 m.m., the smaller size predominating. Their colour for a day or two of their emergence is bright red on the thorax, with white bright lines. Of these there are two median parallel pale lines, and two curved silvery ones, one on each side and a small line in front between the two median ones. The legs are banded and on account of their striped appearance they are known as tiger mosquitoes. The colour gradually darkens to reddish brown, though it is never so dark as it is in Bombay. They bite viciously during the day from 11 a.m. to 3 p.m., and the bite is very irritating. I have never found *S. Fasciata* to become a nocturnal feeder after its first blood meal. Dark clothing attracts them most. Adult *S. Fasciata* were almost always caught inside the houses and out-houses, but never outside or in gardens. The males are more delicate in structure and smaller in size and from any particular sample more males than females hatched out.

5. *The eggs* are ovoid, pointed at one end and rounded at the other, and are surrounded by a series of little air chambers. They adhere to the sides of the vessel or to the material on which they are laid, and are difficult to remove.

6. *Life History.*—The following points in their life history were noted. Three series of cage experiments on isolated couples were done; (the cages used were 1 cubit feet in size, were made of wooden frames with fine cloth gauze stuck all round. They were well protected from spiders or ants. The mosquitoes were fed on black raisins, and a dish of water with pieces of pith floating was kept in).

In the 1st series, where no feed of blood was given, no egg-laying was ever seen, though mating was often noticed.

In the 2nd series, the couples were fed on blood on the first day of their emergence, and subsequent feeds were given ten days after the last batch of eggs was laid. This period was allowed to elapse in order to observe whether one feed of blood was sufficient for the egg-laying function for all their life. Copulation was not seen earlier than on the third day, and on the sixth day or later, the first batch of eggs was laid, the number of eggs varying from 24 to 44; in a few cases a second and a third batch of 8 to 12 eggs was laid in two or three days more. Similar results were noted after the 2nd and 3rd feed of blood; but the female never outlived the 3rd egg-laying period, the maximum number of eggs laid during the lifetime of one female being 64.

In the 3rd series, it was attempted to give the female frequent feeds of blood. In the majority of cases she refused to bite and the results in no way differed from that of the second series.

The males died off earlier than the females, 12 days being the maximum period of their lifetime. New males were always supplied. The female lived from four to five weeks.

The eggs were laid singly during the night time and some of them immediately sank though an almost perfect rim of floats could be seen around them. 25 per cent. of them hatched out during the first 24 hours; but even after three days 20 per cent. still remained unhatched. These unhatched eggs, after remaining in water for a fortnight, were dried and a few days later were placed under suitable conditions for hatching. Out of these only a few hatched out at different times during these three months, but the others, 8 per cent., are still just the same. Whether they are unfertilized eggs, or some form of resistent eggs, I cannot say. Another batch of eggs, which were dried soon after being laid, were after three months placed under suitable conditions and these hatched out with the above reservations.

No statement can be made as regards the seasonal variation of *S. Fasciata* in the same locality, nor of their prevalence in different parts of the city at any one particular period.

7. *Stegomyia Scuttalaris.*—An attempt was made to find out whether any of this species exist in Karáchi through escaping detection. Hollow test-tubes like bamboo stumps full of water were placed in different parts of the city. No *scuttalaris* were caught in two months. But a new species, not met with so far, bred in a few of them. This was identified as *Theobaldia Spathiapalpis.*

Section 3.

1. *Culex Fatigans.*—Swarms of the adult mosquitoes haunt many of the houses in the city and they were exclusively caught when *Anophelines* or *Stegomyia* were looked for. Drains, gutter-traps, cess-pits are mainly responsible for them.

2. *Culex Concolor* have a distribution like that of *C. Fatigans* and were always found in association with the same. Their breeding places number about 8 per cent. of those of *C. Fatigans* and are mostly wells.

3. *Culex Taeniorhynchies* was found only once in salt water of a marsh along with *A. Rossi.*

4. *Theobaldia Spathiapalpis* was found in bamboo traps set as mentioned above.

5. *Anopheles Stephensi.*—Its breeding grounds are about 2/3rd of the total for *Anophelines.* It was found under all conditions living quite happily and did not die in sampled bottles. As may be seen from the analysis, it was found in sweet as well as brackish water and in the back waters of the sea; in garden tanks but specially in the garden drains and water-logged areas; in very foul manure pits. It is impossible to give an opinion as regards their choice of breeding place.

6. *A. Rossi.*—Nothing unusual noted.

7. *Cellia Pulcherima* was found only once in a big garden tank.

8. *Desvoidea* were not met with.

9. *Phlebotomus.*—The sand fly was found everywhere and is a great pest at Manora.

10. *Chironomus* are found everywhere in clean water, *e. g.*, garden tanks, cattle troughs, etc.

The Natural Enemies of Mosquitoes.

Section 4.

The water-boatman, belonging to the order Notonectidae, is very often found in tanks and under experimental conditions they devour both *Culcines* and *Anophelines.* But in tanks, live larvae could always be caught. Minute water bugs, dark grey in colour and 1/16th of an inch in length, were found in wells and tanks and keeping down the number of larvae. The larvae of May-flies—*Ephemerae*—are also very destructive. It is doubtful though whether even a large number of these will serve to keep a breeding place free of larvae. Fish, unknown, were found in three big tanks and one well. In spite of all attempts no larvae could be found in these.

An attempt was made to experiment on local small sea-water fish, but they invariably died before a satisfactory conclusion as regards their feeding on larvae, could be arrived at. They are awaiting identification, and if from their habits in other places, they are of the right kind, it will be possible later to experiment on them.

CHAPTER V.

Preventive Measures.

Section 1. Karáchi is a small place as compared with other places where mosquito destruction is carried on successfully. All the breeding places are artificial, and not natural. There are no water-courses, pools, etc., and the marshy area can be entirely ignored as it exceptionally harbours larvae; and with the expansion of the city it is sure to be reclaimed in future and thus cease to be a menace. The rainfall is negligible in quantity and the adventitious breeding places can be easily kept under control. There do not, therefore, appear any great physical obstacles in the way of mosquito destruction. To add to the facilities in overcoming the same, are the sandy porous soil and the heat of the sun. All collections of water, artificial or natural, dry quickly because of the sandy nature of the soil.

Summary of the economic conditions, customs of the people, etc.—The greater part of the population is concentrated in the northern half of the town. Most of them are poor, and are attracted here by work from distant parts, *e. g.*, Deccan, Konkan, Cutch and Gujarát ports, etc. They live in chawls or lines closely built together with only one living room to serve for a good many of the people. The rooms are dirty and often full of smoke and where there are no women in the house the place is very unclean. Each of these houses has a courtyard of its own which is utilized for keeping animals of all kinds, and thus instead of the courtyard being a luxury, it becomes an abominable nuisance.

Water-supply.—On referring to old maps we find that there are twice or thrice as many wells as there are now but they are all filled up. As to who took the initiative and why they were filled up could not be ascertained. Perhaps it was the pipe water-supply that did away with the necessity and the present wells too are in a rotten condition because of disuse. Every house is not provided with tap water, the pressure is low and the supply intermittent, and the water in many cases has to be brought over from across the road. Big gharras are used to store the water and a fresh supply is added everyday without removing the remnants of the previous day. The first and paramount necessity, therefore, of the city is to increase the water-supply to such an extent as to enable every householder to dispense with the use of gharras and the wells.

Section 2. The measures required for the prevention and destruction of these breeding places fall into two classes :—

Those for—

I. Permanent breeding places.

II. Temporary breeding places.

These shall again be discussed under two heads—

A. General measures.

B. Special measures.

I. In the survey it has been shown that the commonest permanent breeding places are—

1. Open wells.

2. Open and imperfectly closed house cisterns.

3. Garden and other tanks, fountains, tubs, etc.

4. In certain localities special places exist in the marshy areas and the backwaters in mangrove swamps from the sea.

The first step of a general measure for controlling these, must be a strict limitation of their number and no increase of their potential breeding places must be allowed. At the present time wells are dug open or improperly closed, cisterns are erected, fountains and tanks constructed, garden and other tubs multiplied, without let or hindrance. The danger is great and the community must be protected from further risk by stringent regulations. The existing

places must be registered and a license obtained for keeping them. Even a nominal fee will have a deterrent effect.—

i. The construction of new open wells must be strictly prohibited.

ii. The erection of new cisterns must also be strictly prohibited, and these should be made to conform to a given standard of safety as regards protection from mosquitoes.

iii. The use of garden tanks and tubs should be subject to regulation and their multiplication should be restricted.

Having taken steps to restrict these, it will be possible to set about the reduction of those already in existence :—

i. Wells.—The protection of these is an important measure. The subsoil level of the water is very near the surface and not much trouble is required to dig a new one; all the wells are open and most of them kutcha built, *i. e.*, the brick and concrete work extends to a depth of few feet only, the result being that the earth work at the bottom crumbles away making the whole structure unsafe; and worse still, it allows an easy contamination from surface drainage; and the water in some cases is so foul that even fish will find it difficult to live in them. 60 per cent. of the wells breed larvae, and 2 per cent. those of Stegomyia. From very few wells is water taken for drinking purposes and religious ceremonials, and the great majority of them are used for purposes of washing, bathing and for animals. 62 of the total of 513 wells are never used and the owners are willing to close them. An increased water-supply and laying on of taps to every house will easily do away with this nuisance and dispense with the necessity of storing water in gharras—

A. Owners should be obliged to register the wells and protect them in any of the following ways and allow a periodical inspection.

B. (i) They can be filled up and permanently closed (all foul and sewage contaminated wells must be closed).

(ii) They can be completely covered with stone or brick work, or enforced concrete, with no opening except that for the pump to be used for drawing water (the depth of no well will preclude the use of a hand-pump).

(iii) They may be similarly covered, and a small opening left, which is fitted with trap door and stocked with suitable fish. The trap door should have iron gauze with 20 meshes to the inch and be provided with a padlock. These should be allowed only in cases after personal inquiries.

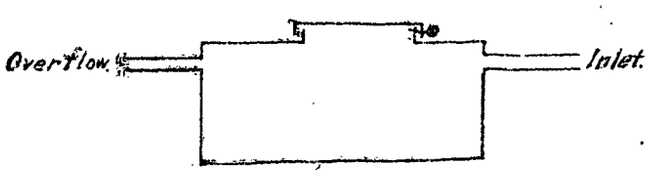
(iv) Or if a well cannot be concreted, it should be similarly stocked with a sufficient number of fish and kept always free from weeds and floating matter.

If in spite of these precautions the well cannot be kept free, *e.g.*, from the neglect of the residents, steps should be taken to close the well.

2. Cisterns.—These are at present badly constructed and badly situated They are sometimes on top of houses, and are fouled by dust and excreta of birds, etc., or in cramped places as under stairs where rats, cockroaches, etc., have an easy access to them; most of the residents think that the lid is superfluous. Those that were exposed to the sun, were mostly free from larvae because of the heating of the water :—

A. A license and a periodical inspection.

B. i Perfect fitting trap doors and the open end of the over-flow pipe should be covered with gauze.



ii Thorough cleaning every 10 days.

iii They should, whenever possible, be built exposed to the sun.

3. Garden tanks.—These should be erected according to the necessities of a garden and not the comfort of the "mali". They should not be sunk in the ground, and the water tap in connection with them must always be inspected and show no leakage. They should be built of bricks and concrete, and plastered all round and should have an opening at the bottom to clear out all possible traces of water and thus allow of thorough scouring. Fish for these cannot be advised, nor a wire-meshed netting, as this will soon get damaged. Putting kerosine on top is no good too, as the wind carries it all to one corner, and forms blebs leaving a greater part open, in which larvæ do live and thrive. Whenever there are more than two such in a garden they should be periodically dried in the sun every 8 days. Fountains may be stocked with fish of a suitable kind.

The general measures for garden tanks, fountains, cattle troughs, etc., are:—

A. A license and periodical inspection.

B. Cleaning and occasional drying.

The plot of ground around these should be always kept dry and never be allowed to get water-logged. These wells and tanks can be rendered innocuous at little expense and should remain so.

Garden drains.—Of these there should be always as few as possible and all should be brick-built and well levelled to allow no pools of water in their course. They should not pass close to a house. The pernicious habit of allowing a constant flow of water to pass through them and soak plots at leisure must be steadily discouraged. They should be thoroughly swept out and allowed to dry (most of these water-logged areas breed *Anophelines*).

Garden tubs should be periodically emptied and scoured.

Drains and gully traps should be inspected every 8 days and the traps pesterined.

II When we come to consider the temporary breeding places, the outstanding difficulty is the insufficient supply of water to every house, and the consequent necessity of storing it in receptacles according to the means of the tenant. Gharras, tubs, soda-cooling chatties, flower pots, antiformicas, fire-buckets, etc., must all be emptied out in the presence of the inspecting staff. Large sizes should be steadily discouraged. Disinfectants cannot be used.

A. i Supplying taps to every house.

ii Periodical inspection every 10 days.

iii The breeding of larvæ on the premises must be dealt with as an "offence" and should entail a penalty.

iv Erecting and keeping under control experimental breeding grounds.

All collection of waste water, round stand-pipes and in hollows of masonry works of tanks, and around the mouth of wells, should be carefully inspected and promptly filled up. Solid surface drains should be constructed to carry off all waste water.

The killing of the residual adult mosquito appears an entirely unnecessary measure, provided that a locality far and round is kept constantly under control. If necessary, as in holds of ships, sulphur should be burnt in a closed space—$1\frac{1}{2}$ lb. to every 1,000 cubit feet of space.

Special traps:—It must be remarked that it will not be sufficient only to inspect and cleanse the temporary breeding places of *S. Fasciata*. There are millions of adult mosquitoes existing, and as soon as their favourite haunts are abolished they will seek other suitable locations and in the absence of these, such unusual places (in Karáchi) as wells and garden tanks, cess-pits, etc. This being the case it will certainly follow that any well, etc., in the neighbourhood if not already infected will speedily become so. Starting, therefore, with the premise that the present temporary breeding places are well under control, a special catch-place, as a tub full of water, should be prepared for them. These should be located in every group of 50 or 100 houses. They are in no case to be touched but for the emptying and cleansing of them every eight days. These will serve to attract the flying adults and induce them to lay their eggs therein.

Fish.—There appears to be every reason to believe that fish of the right kind can successfully be employed in protecting wells, tanks, fountains, etc. :— Section 3.

(i) the number of fish to be employed should be proportional to the amount of the surface of water to be protected.

(ii) the water should be kept free from weeds, floating matter, etc., which afford protection to larvæ.

The local fish are awaiting identification.

Larvacides.—No experiments were made locally but the following can be recommended :—

1. Kerosine is most effective than pesterine and a mixture of the two in equal parts is more efficient. Pesterine is cheap, and its colour shows when applied. These should be applied as a spray and the "Success Sprayer" works well.

2. Dr. Bentley's modification of Gorgas' Larvacide :—

Carbolic acid, crude	...	...	100 gals.
Resin ...	...	...	330 lbs.
Solution of caustic soda	...	...	(100 lbs. of the soda in solution.)

The resulting preparation when cold is a thick dark brown mass of paste. This is heated up and diluted with three parts of water and is used as a stock emulsion :—

Emulsion 1—1,000 kills S. F. Larvæ in 8 minutes (one teaspoonful to a gallon).
Emulsion 1—5,000 „ „ 20 minutes.

It is found to have more action on larvæ than pupae and nearly mature larvæ pupate rapidly on coming in contact with it. So that it is a good plan to combine kerosine or pesterine with it in equal parts. Half ounce to 1 square yard.

Improved drainage will not in any way affect the prevalence of *Stegomyia* or *Anophelines*. There is great danger, however, that if proper precautions are not taken it will still further increase the number of *Culicines*.

It is a most significant fact that during the investigation, no difficulty was experienced in any part of the city in dealing with uneducated and poor people. Whenever the important fact of the presence of larvæ in their drinking water is brought home to them, they are extremely careful not to let it occur again, and though most of them are both illiterate and ignorant, they are not so apathetic. They accept without question the wholesome advice given. Many of the householders are willing to have the wells closed, and as regards temples and mosques, a satisfactory solution can be easily arranged by consultation with the leading citizen. Religious and caste prejudices will not interfere. I was always received with friendliness and though the presence of a Government official naturally creates some alarm, still with a little patience and coaxing, work can be more satisfactorily done, than with a show of authority.

CHAPTER VI.

The Cost of Mosquito Prevention in Karachi.

Section 1.

It is necessary to go into the question of the cost of efficient mosquito work in Karáchi in some detail, in order to get an idea of the staff and organisation required for such work; It is possible to deal with this question in three different ways :—

Scheme I.—The prevention and destruction of mosquitoes of all species.

Scheme II.—The prevention and destruction of *Stegomyia* only, throughout the city—(a relative extermination of these is worth attempting).

Scheme III.—The prevention and destruction of Anopheline mosquitoes.

At the census of 1911 there were 31,000 occupied houses and here the term house has not such a wide significance as it has in Bombay. This number is used as a basis on which is estimated the cost of a scheme. For the purposes of a working basis, the different quarters are grouped according to the character of houses in each locality—see table IV-A and IV B.

Before any of these schemes can be carried out it is necessary to have a thorough careful inspection of all the premises, occupied or unoccupied, at intervals of not less than 8 days, by a trained Inspector. In addition to this house inspection, the Inspectors will have to examine the immediate surroundings of each, in order that no other likely place escapes attention. The status of the Sub-Inspectors must also be considered. A trained cooly is as good as any one, for the mere discovery of the mosquito larvæ, but they can never be used as Inspectors. There is the same difficulty in the use of men of a superior stamp, *i.e.*, "Mukadums". Power of entry to private houses can not be delegated to men below the standing of a Sub-Inspector.

In other places where mosquito prevention is carried on, not more than 25 houses are allocated to one Sub-Inspector. In these schemes a higher number has been assigned deliberately for the following reasons :—

1. The system of numbering the houses is different.

2. The total possible number of breeding places is much less, on account of less rainfall and sandy soil.

3. Personal experience.—I could examine all the houses in the outdoor work of 3 to 4 hours ; an equal time can with justification be added to carry out the preventive measures.

Scheme I.—Inspection every 8 days should be decided on.

Group A comprises 6,668 houses; one Sub-Inspector can readily examine 30 houses a day ; *i.e.*, 200 houses per week. 30 Sub-Inspectors will therefore be required.

Group B 13,861 houses. One Sub-Inspector can examine 40 houses a day, *i.e.*, 280 per week. 50 Sub-Inspectors will be required.

Group C 10,900 houses. 75 houses on a liberal average can be examined, *i.e.*, 525 houses per week. 20 Sub-Inspectors will be required.

That is, a total number of 100 Sub-Inspectors will be required for the whole of Karáchi. Each of these will require two coolies to help them and carry the appliances and material required for discovering and destroying mosquito larvæ ; it necessitates an extra staff of 200 coolies. Again it would be necessary, to have proper control of the subordinate staff, that the superior inspecting staff must be increased. An Inspector cannot supervise the work of more than

10 Sub-Inspectors as this would allow him to devote two or three working days a month for the work of each individual Sub-Inspector in his charge. 10 Inspectors will thus be required.

It has been found that there are about 500 wells in the city and over 60 per cent. of these are mosquito breeding places. 80 of these are absolutely useless and never used by anybody. In addition to these there are an equal number which the owners will permit to be closed with a little persuasion. There thus remain 350 wells to be absolutely dealt with. These will require inspection and periodical cleaning. They also need to be stocked with larvae-destroying fish. For this purpose special gangs of men under a good Mukadum must be employed for periodical cleaning at least once in two months. A gang of four men and one Mukadum can cleanse efficiently 30 wells a week on an average, as the majority of the wells are too shallow. That is, two such gangs will be enough all the year round.

The great amount of routine work rendered necessary by the adoption of such a scheme would require proper control and co-ordination, and this can only be done by placing one responsible officer in sole charge of anti-mosquito measures. This officer should be an Assistant to the Health Officer and would require to be specially trained or to have had special experience. It would soon be found that the effect of more constant inspection will necessitate an increase in the number of men employed in cleansing the city, and for the work of filling in and levelling small pools and hollows, and abolishing minor breeding places, an increased number of coolies, Mukadums, bullocks, etc., will be required.

(The following figures have been arrived at in consultation with the Health Officer, Karáchi.)

The total staff then comes to :—

100 Sub-Inspectors at Rs. 20, each per month	...	...	Rs.	24,000
200 Coolies at Rs. 12	„	...	...	„	28,800
10 Inspectors at Rs. 75	„	...	...	„	9,000
2 Well-cleansing gangs of 4 men and 1 Mukadum each	...	„	1,500
Health Officer at Rs. 350 ; 2 clerks at Rs. 60 each and 2 peons at Rs. 12 each, etc.	...	...	...	„	6,500
Material Larvacides, etc.	...	...	...	„	10,000
Increased cleansing work	...	...	...	„	5,000
Total	...	Rs.	84,800

or in rough figures Rs. 90,000 per year will be required.

Scheme II.—It is perfectly possible to rid the city of *Stegomyia* alone. It is not necessary to undertake such careful work as detailed in Scheme I. The inspection will be chiefly limited to temporary breeding places (mentioned in chapter III) and of the permanent ones—wells and garden tanks very near the houses. Against this has to be set down the fact that every house must be visited. The life-cycle of *Stegomyia* larvæ teaches us that an inspection every 10 days will leave an ample margin. All things considered the amount of work to be done will be lessened by about half. Allowing a third more of the houses to be inspected by each Sub-Inspector and insisting on a ten days' instead of a weekly interval, we have for Scheme II :—

Group A—400 houses every	10 days	...	15	Sub-Inspectors.
Group B—560 „	„ 10 „	...	25	„
Group C—1,050 „	„ 10 „	...	10	„

The total staff on the same calculation comes to :—

50 Sub-Inspectors	...	...	...	Rs.	12,000
100 coolies	...	...	...	„	14,000
5 Inspectors	...	...	...	„	4,500
2 well cleansing gangs	...	...	...	„	1,500
Head Office establishment	...	...	...	„	6,500
Material, Larvicides, etc.	...	...	...	„	5,000
Increased cleansing work	...	...	...	„	5,000
Total	Rs.	48,900

or in rough figures Rs. 50,000 per year.

Scheme III.—This is the simplest of the three. The work will be limited for the inspection of the wells, garden tanks, and garden drains, cisterns, floral fountains and cattle-troughs. The prevention of mosquitoes in marshy areas involves the consideration of reclamation, etc., quite beyond the scope of this paper. All the above permanent breeding places are not more than 4,000 in all and leaving the wells out of consideration for a time, there are only 3,500 places to be dealt with on the whole. Now, it often happens that 3 or 4 of these are included in the compound of one house. But the distances which the working gang must go over in one day, shall also have to be considered. With a wide and a liberal margin, therefore, 30 such places—*not houses*—can be inspected and cleansed in one day and with an average inspection every 8 days, 15 Sub-Inspectors can do the work easily. The well-cleansing and fish-stocking gangs shall have to be retained, as also the charges on disinfectants. In the case of this particular anti-malaria campaign the Health Officer in charge will be burdened with the extra task of a periodical spleen census in different areas and the careful collection of returns from hospitals and dispensaries, corrected, whenever necessary, by microscopical observations.

The total then comes to:—

15 Sub-Inspectors	...	Rs. 3,600
1 Inspector	...	„ 900
30 coolies	...	„ 4,320
2 well-cleansing gangs	...	„ 1,500
Material larvacides, etc.	...	„ 5,000
Increased cleansing work	...	„ 5,000
Head Office establishment	...	„ 6,500
	Total	Rs. 26,820

or in rough figures Rs. 26,000 per year.

Section 2.

For the success of the operations detailed in these schemes, the area should be divided into sections of 1,000 houses each. Each of these sections should be divided into beats for each Sub-Inspector. Wholetime men must be employed to make a determined and constant attack on mosquitoes. All possible breeding places must be noted, as also every place where larvæ are found. A diary must be kept of the places visited and the whole staff must be clearly given to understand that their sole duty is to prevent mosquitoes breeding in their charge. Failure to prevent the breeding must be immediately reported. The whole staff should be regularly coached up in the routine work and in the method of inspecting wells, etc.; and distinguishing between *Anophelines*, *Culex* and *Stegomyia*. Each Sub-Inspector should be supplied with a ring-net, sauce pan, spoon, bottle, etc., and a card (like the one used in Bombay) should be filled in and returned to the officer to take further steps.

Public Health Department.

_____Quarter_____ Section_____Street.

House No._____ Name of owner_____

Class of occupier_____

Type of closet_____

Position of cistern_____ Larvæ present _____

Position of well_____ Do._____

Date of 1st inspection _____

Date of 2nd inspection_____

Date of action _____

Result of action taken_____

Subsequent inspection and remarks_____

Name of Inspector_____

All unused wells should be filled in as soon as possible. Those that are required for use should be covered and arrangements made for suitably raising the water by a hand-pump. Special traps, as detailed in Chapter V, should be set. All breeding places should be styled as a Dangerous Nuisance. The

stable and cattle yards should be paved and drained or totally abolished. All tins and rubbish should be removed to prevent an accidental filling of these with water. Privy pits should be kerosined and barrels screened.

Private individuals should be encouraged to do much by not allowing to remain near their houses any accumulations of water, by preventing its waste and overflow, and by seeing that all tanks and cisterns on their premises are closed properly or are larvæ free. No details should be left to the discretion of the servants. For this purpose it is necessary to distribute pamphlets to householders, etc., describing the various precautions against breeding mosquitoes. Education in sanitary ideas is essential before an attempt can be made to start anti-mosquito measures, and knowledge must be diffused steadily until it is shared by officials and non-officials alike.

CHAPTER VII.

Final Conclusions.

It has been shown in the previous chapters that there is real danger of Yellow Fever to India from increased trade communications with the East, and Karáchi will be one of the portals of its admittance if precautions are not taken in time—first because of its situation and rising importance as a maritime port, secondly from the universal and unchecked distribution of *Stegomyia Fasciata*, and thirdly the non-immunity of the population. It is desirable, and is perfectly possible, to control the second factor and exterminate the *S. Fasciata* or at least to so limit its dissemination that it will cease to be a potential danger. In the previous chapters has been discussed the prevalance of only one species—*S. Fasciata*—its distribution in the harbour and the city, a consideration of their breeding places and the factors which will influence them, and it has been clearly shown that in the absence of an ample water-supply, each house is a possible focus of infection.

It is necessary to point out that the harbour is so well isolated from the city that even if it is decided to draw the cordon of mosquito prevention round the harbour alone instead of the whole city, it is perfectly possible to prevent the yellow fever from finding a permanent foothold.

The measures suggested are practicable though requiring constant attention to minute details and much arduous work. Mosquito prevention, in order to be successful, must be carried on indefinitely and without relaxation. The cost of the scheme is not prohibitive and when considered with figures for other ports, stands a favourable comparison.

The whole responsibility of the measures must rest on the authority in charge, and not on the residents who can learn nothing and their reliance on measures will engender a false sense of security. The ultimate success will be ensured by co-operation with the public, *i. e.*, more by explaining to them than forcing them to do a thing blindly. As far as natural difficulties are concerned the problem is an easy one, and the more rapidly they are encountered over a whole area, the more certain will be their complete success.

APPENDICES.

TABLE 1.

Mean Maximum and mean Minimum Temperature—monthly averages taken in Karáchi for five years 1908—1912.

Months.	1912.		1911.		1910.		1909.		1908.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January	77·3	61·1	72·3	57·4	74·8	57·5	73·5	55·7	77·1	55·3
February	80·7	63·2	77·5	61·6	80·0	62·5	78·9	60·5	80 5	56·6
March	84·0	66·5	79·0	66·6	81·7	66·5	83·7	66·7	85·6	63·8
April	86·2	75·6	84·3	72·6	85·8	72·8	85·8	74·5	90·2	73·3
May	89·1	79·0	87·9	78·4	86·7	77·0	91·2	76·4	94·2	77·7
June	91·8	83·6	88·5	80·6	90·8	81·5	91·0	83·1	95·0	82·6
July	89·6	82·1	86·6	79·3	87·5	80·2	88·6	80·4	88·8	79·8
August	87·3	79·5	85·1	77·8	85·3	77·3	83·4	75·2	85·8	77·6
September	86·1	75·7	85·3	77·0	85·0	75·6	86·1	75·2	85·7	75·6
October	88·3	73·0	85·4	73·4	86·3	72·1	86·5	73·3	85·4	72·2
November	84·7	66·0	83·2	65·0	84·5	66·2	85·3	70·2	83·0	85·1
December	78·9	59·6	78·8	58·9	77 9	59·1	77·6	60·5	78·8	59·5

TABLE 2.

Vapour tension mean and Humidity mean at 8 a.m.—monthly averages for five years 1908—1912.

Months.	1912.		1911.		1910.		1909.		1908.	
	Vapour.	Humidity.	Vapour.	Humidity.	Vapour.	Humidity.	Vapour.	Humidity.	Vapour.	Humidity.
January	·399	65	·334	62	·337	61	·333	63	·369	72
February	·455	66	·465	73	·441	68	·384	61	·370	63
March	·509	64	·564	76	·538	68	·525	66	·552	66
April	·838	82	·736	80	·697	73	·759	78	·725	70
May	·930	81	·877	81	·891	86	·774	68	·848	72
June	·980	77	·946	84	·965	80	·981	80	1·004	77
July	·975	82	·873	82	·920	82	·934	84	·989	88
August	·893	82	·839	83	·865	86	·815	83	·899	88
September	·820	81	·833	83	·795	82	·781	80	·821	83
October	·719	74	·764	81	·728	79	·747	79	·798	76
November	·463	59	·454	59	·494	66	·636	73	·541	73
December	·333	56	·291	50	·344	57	·341	60	·363	62

TABLE 3.

Monthly-averages of rainfall from 1908 to 1912 and monthly averages of wind in 1912.

Months.	Rainfall 1908—1912.										Wind 1912.				
	1912.		1911.		1910.		1909.		1908.						
	Rainfall in inches.	No. of rainy days.	Rainfall in inches.	No. of rainy days.	Rainfall in inches.	No. of rainy days.	Rainfall in inches.	No. of rainy days.	Rainfall in inches.	No. of rainy days.	Components of the wind.	Nature of wind.	Maximum No. of miles in one day of the month.	Minimum No. of miles in one day of the month.	Mean velocity in miles per hour derived from 24 hourly observations.
January	...	...	0·50	2	0·37	1	0·68	2	0·85	2	S.W. ; N.E. ...	Light breeze ...	590	119	9·9
February	...	...	0·02	...	...	...	0·01	...	...	...	S.W. ; N.W. ...	Light to moderate ...	612	146	13·0
March	...	...	3·83	6	...	...	...	...	...	...	W.N.W. ...	Moderate ...	614	157	13·3
April	...	...	...	...	...	...	...	...	...	...	W.S.W. ...	Moderate and strong .	632	264	15·7
May	...	...	...	...	...	...	...	...	...	...	W.S.W. ...	Do. ...	602	235	17·1
June	...	...	...	...	2·29	2	...	...	...	...	S.W. ...	Do. ...	674	277	20·9
July	2·77	2	...	...	8·14	3	5·03	3	5·11	4	W.S.W. ...	Do. ...	690	221	20·2
August	0·38	1	0·09	...	1·73	3	0·63	1	0·49	1	W.S. ...	Do. ...	736	193	19·2
September	0 02	...	0·12	1	...	...	0·02	...	0·01	...	W.S.W. by W.N.	Do. ...	609	160	16 1
October	...	...	...	...	...	...	...	...	...	...	N.N.E. ; N.N.W.	Light ...	339	100	9·8
November	...	...	0·28	1	...	...	...	...	...	...	N.E. ...	Do. ...	512	134	7·8
December ...	...	...	...	...	0·10	...	0·72	2	...	...	N.E. ...	Do. ...	524	52	9 5
															14·4

TABLE 4-A.

Census of 1911.

Group.	Quarter.	Area in acres.	Number of occupied houses.	Total number of persons.			Density per acre.
				Male.	Female.	Total.	
A	1. Civil Lines	505·96	252	1,563	795	2,358	4·66
	2. Frere Town bath Island and Clifton.	254·82	260	843	529	1,302	5·38
	3. Railway and Queen's Road...	258·96	34	166	58	225	0·86
	4. Serai	172·17	1,653	5,055	2,605	7,660	44·48
	5. Rambagh	161·15	1,348	3,664	2,250	5,914	36·68
	6. Preedy	64·69	347	765	526	1,291	19·99
	7. Garden quarter	940·30	2,711	7,259	5,345	12,601	13·41
	8. Ghizri, etc.	156·10	63	218	183	401	2·56
B	9. Old Town	32·83	1,235	2,450	2,078	4,528	137·95
	10. Napier	45·80	1,987	5,611	4,315	9,926	216·56
	11. Market	37·88	963	3,169	2,409	5,578	168·94
	12. Bunder	30·25	291	1,203	292	1,495	49·42
	13. Jail	91·13	1,459	3,698	2,571	6,269	68·25
	14. Runchore	204·54	4,559	10,519	6,731	17,250	84·34
	15. Ramswami and Begarikhatta.	66·56	1,252	2,332	1,736	4,068	61·11
	16. Soldier Bazar	44·98	346	654	487	1,141	25·36
	17. Sadar Bazar	126·26	1,769	5,310	3,580	8,890	74·12
C	18. Lyari...	918·27	7,118	17,378	14,571	31,949	34·79
	19. Machimiani	70·48	1,265	3,521	2,762	6,283	89·14
	20. Kiamari	172·17	1,220	3,566	1,961	5,527	32·11
	21. Manora, Baba bhit	24·37	121	411	330	741	30·40
	22. Maurypur and Shawapir and scattered hamlets.	84·93	1,180	2,674	2,371	5,045	59·40
	Total ...	4,465·30	31,433	82,026	58,485	140,511	...
	Add that of Railway limits ...	...	...	3,841	1,283	5,124	...
	Harbour	...	...	2,148	69	2,217	...
	Cantonment—Military charge ...	...	...	4,680	954	5,634	...
	Cantonment „ ...	...	...	3,529	2,231	5,760	...
	Grand Total ..	...	...	96,265	63,005	159,270	...

TABLE 4-B.

Total Number according to Groups.

Groups.	Area in acres.	Number of occupied houses.	Total Population.	Density per acre.
Group A (1 to 8) ...	2,514·15	6,658	31,821	12·25
Group B (9 to 17) ...	680·93	13,861	59,145	88·33
Group C (18 to 22) ...	1,270 22	10,904	49,545	39·05
Total ...	4,465·30	31,433	140,511	.....

TABLE 5.

Population according to race in 1911.

Names.	Males.	Females.	Total.
Mahomedans	38,996	31,548	70,544
Hindus	38,582	23,846	62,428
Christians	2,434	1,524	3,958
Parsis	981	931	1,912
Jains	434	213	647
Others	599	423	1,022

TABLE 6.

Causes of death.	1911-1912.		1910-1911.		1909-1910.	
	Number of deaths.	Death rate per 1,000.	Number of deaths.	Death rate per 1,000.	Number of deaths.	Death rate per 1,000.
Fver	828	5·64	668	4·51	696	6·40
Small-pox	11	0·07	24	0·16	12	0·11
Cholera	9	0·06	38	0·35	...	0·00
Accidents	31	2·20	23	0·15	20	0·18
Stomach and Bowel complaints...	123	0·83	83	0·56	88	0·18
Plague	2,768	18·71	1,681	11·36	2,069	19·04
Other causes	2,818	19·05	2,799	18·92	2,283	21·01

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NOTES

ON THE OPERATION OF THE

HOUSING AND TOWN PLANNING, ETC., ACT, 1909, AND ALLIED MATTERS

BY
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NOTES ON THE OPERATION OF THE HOUSING AND TOWN PLANNING, ETC., ACT, 1909, AND ALLIED MATTERS.

[*Report made in connection with a tour in Great Britain in the year 1913. Places visited:—Birmingham, Bournemouth, Bexhill, Bristol, Birkenhead, Chesterfield, Derby, Edinburgh, Hereford, Inverkeithing, London, Letchworth, Liverpool, Manchester, Rochdale, Sheffield.*]

I.—INTRODUCTORY.

1. This report does not attempt to deal with matters contained in the housing portion of the Act but has reference mostly to planning schemes relating to the extensions of a town. It commences with a few general remarks on town-planning and deals mainly with the subjects of 'betterment,' 'the re-arrangement of plots' and 'roads.' The first two subjects form prominent features of the Bombay Town Planning Bill, whilst the provision of roads must be ordinarily a prominent feature of every town-planning scheme. A few suggestions have been made, which have been already incorporated in the Bombay Bill as amended by the Select Committee of the Legislative Council.

II.—GENERAL REMARKS.

2. Town-planning is not a new science but has been practised from ancient times and examples of its use can be found both in ancient Greece and in towns of the Roman Empire. A mediæval example is to be found in the town of Rye in Sussex which was planned by command of King Edward I when the ancient town was destroyed by the inroads of the sea. In more recent times the extension of Edinburgh is a conspicuous example of the happy results of planning. The beautiful area comprising Princes Street, George Street and Queen Street with its wide roads and squares was planned in the year 1767 by a local architect James Craig, whose plan was selected in competition and afterwards carried out in detail, while in order to preserve the magnificent view of the Castle and the old town an Act of Parliament was enacted in the year 1816 rendering it unlawful for the local authority to allow the erection of buildings on the south side of Princes Street. The maintenance of this beautiful view had thus become a matter of national importance. Other parts of the new town of Edinburgh were planned early in the nineteenth century, but mainly owing to the invention of the steam locomotive and the consequent introduction of railways the plans have not been carried out in their entirety. The City of London was also planned by Sir Christopher Wren after the Great Fire in the year 1666, but owing to the absence of co-operation on the part of the citizens his plan was never carried into effect. Such want of foresight has doubtless involved the subsequent generations of citizens in enormous expenditure for improvements, and it is now financially impossible to create such a magnificent city as would have resulted from the adoption in the first instance of the well-considered plan of Wren's. In or about the year 1875, when the English Public Health Act was passed, it is interesting to note that enactments bearing on town-planning were passed in Sweden and Germany. The English Town Planning Act was not passed until the year 1909, but several Garden Suburb schemes had been carried out in recent times before that date. The difficulties experienced in carrying out such schemes on economic principles showed the necessity of less stringent local regulations, which have now been made comparatively easy to obtain by preparing a scheme under the Town Planning Act. Since the passing of that Act only two town-planning schemes have been finally approved, but sanction has been given to local authorities to prepare 33 schemes in England and 16 in Scotland. Several local authorities are also considering schemes which have not yet reached the stage of an application to the Local Government Board to obtain formal authority for their preparation. A certain amount of activity has thus been created amongst local authorities in regard to planning the extensions of their towns, and there appears every indication that the movement will grow as experience of the Act is gained and as the provisions of town-planning schemes are actually carried into effect and their benefits are realised.

[*Price—1a. 6p. or 2d.*]

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3. The control of town development vests in local authorities. Their bye-laws are subject to confirmation by the Local Government Board; but beyond this, Government have no direct control over buildings and streets. Some local authorities have special Acts of Parliament of their own giving them additional powers to deal with these matters; and among the larger towns it seems to be the exception for a local authority not to possess some local private Acts conferring some special powers upon them. The ordinary powers of different local authorities also vary considerably, and are graduated according to the area and importance of their jurisdictions. Several towns too have ancient rights and privileges long since conferred upon them by Charter. The majority of authorities in England however can be grouped under the headings Rural District Council, Urban District Council, Borough, County Borough and County Council.

III.—Difficulties of estate and town development.

4. Some of the chief difficulties of town-planning before the passing of the Act were the rigidity of the local bye-laws, the inability of a local authority to secure co-operation with owners, and the difficulty of compulsorily acquiring land required for public purposes.

The bye-laws more particularly referred to are naturally those relating to streets and buildings. As long as an estate owner complies with the bye-laws he can, under the Public Health Act, 1875, lay out his roads in any directions he desires. He is naturally tempted to align them with sole regard to his own interests and without regard either to the interests of his neighbours or to those of the town as a whole. His roads must be of bye-law width. A less width cannot be allowed, and a greater width cannot be insisted upon. Sometimes such roads are too wide and sometimes too narrow. A road which is too wide unnecessarily increases the cost of development of an estate, whilst a road which is likely to become a main or secondary thoroughfare is often too narrow for future requirements and will have to be ultimately widened at great expense to the public and inconvenience to the occupants of the plots which front upon it. Bye-laws also prescribe how a road is to be made up, the manner in which it is to be metalled, and the width and character of the footpaths. Although the obligations of the bye-laws in these matters may be necessary in some cases, there are many cases in which a less expensive make-up of the road and footpath would not only be sufficient, but would add considerably to the pleasantness of their aspect. The footpaths in the Hampstead Garden Suburb with their grass margins and narrow, yet sufficient, width of flagstones afford a good illustration of this point, and indeed it is by obtaining under an Act of Parliament certain modifications of the local bye-laws that the Hampstead Garden Suburb Company has been able to lay out its estate in such a charming manner and to provide houses at suitable rents. Building bye-laws, it seems generally admitted, have not prevented overcrowding, and they give no power to control the class of house to be erected. There is nothing in them to prevent a slum becoming established in the midst of a fashionable residential quarter, and one of the greatest benefits of the Town Planning Act is the power granted to the local authorities of limiting the number of houses per acre that may be erected without making themselves liable thereby to the payment of compensation (section 59 (2)). A builder is not entitled under existing laws to compensation for being made to obey Municipal bye-laws, and the power of limiting the number of houses to the acre is really only equivalent to an alteration of the bye-laws, but all the same a speculative builder might be badly hit if he finds that he will only be allowed to erect under a town-planning scheme a fewer number of houses than he calculated he would be allowed to build when he acquired the land. After a scheme has been approved a speculator will know exactly how many houses per acre he will be allowed to build and will arrange his offer for the land accordingly. Whether the estate owner's profit will be reduced by the limitation remains to be seen, but Mr. Raymond Unwin, a well known expert, in his pamphlet entitled "Nothing gained by Overcrowding" attempts to show that owing to road charges no pecuniary benefit is really gained, and that the effect of the limitation will be to bring more land into the market to the pecuniary benefit of the sum total of

landowners. The power to limit the number of houses per acre will certainly enable the different classes of houses to be arranged properly and will distribute the rise in land values created by a demand for building over a large number of estates instead of confining such rise to the small number of owners whose estates immediately adjoin the developed portion of a town. Both street and building bye-laws can be varied practically to any extent by the provisions of a town-planning scheme, and in fact they must be varied if amenity is to be secured. The rigidity of bye-laws has tended to stereotype the plan of development. When properly varied they enable a town to preserve its individuality and to be designed and built in accordance with the best conceptions of architectural and artistic beauty. Co-operation is required between owners in laying out their respective estates, and between the local authority and the owners in regard to the requirements of the town as a whole. The ordinary powers of a local authority are insufficient to enforce a particular lay-out of an estate, but under a town-planning scheme the planning of estates in a particular manner can be rigidly enforced. An owner would be entitled to claim compensation for any damage that he might sustain by reason of his own particular estate not being laid out in the most lucrative manner possible, but as a set-off to this the local authority has a claim to half the betterment of the estate due to the making of the scheme; and this fact combined with the discretionary power given to local authorities of varying the bye-laws in regard to streets and buildings arms a local authority with powerful means of inducing owners to come to terms with them. Take the case of a road that may be required for the convenience of the town generally. It is important that the local authorities should arrange that the owner of an estate through which it passes should consider the portion of such projected road within his estate as a road to be laid out by him when he wishes to develop his estate. If the road required by the scheme is wider than that required by the bye-laws it would only be equitable for the local authority to pay for the extra width or give some equivalent concession as regards other roads that the owner may wish to construct or as regards the space about any building he proposes to erect. Cases may also arise in which the local authority requires a road to be constructed immediately but the owner of the land through which it passes is not ready to develop his estate. In an example of this sort at Liverpool the owner agreed to surrender the necessary land on payment of a rent fixed at agricultural rates and the local authority undertook the work of construction, the owner agreeing to pay the local authority the expenses of construction when he built.

In all cases efforts are made by the local authority to effect agreements between all parties concerned and the terms of the agreement may or may not include money payments to be made either by one owner to another or by an owner to the local authority.

5. Compared with the manner in which land can be obtained for public purposes in India, the compulsory acquisition of land in England is both tedious and expensive and the officials of local authorities try to avoid it as far as possible. There are two ways to proceed to acquire land compulsorily, one being by Provisional Order of the Local Government Board and the other by obtaining an Act of Parliament. The former way is described in section 176 of the Public Health Act (England) under which a local authority must notify by publication in either September, October or November its intention to acquire compulsorily. One month after such publication notices have to be served on all owners, lessees and occupiers of the lands required and after replies to such notices are received a petition may be made by the local authority to the Local Government Board asking for compulsory powers of purchase. The Local Government Board then considers the petition and may either dismiss it summarily or direct a local inquiry to be made. If any owner, lessee or occupier objects to part with his land then a local inquiry must be made. The inquiry is generally held by a Local Government Board official, and after its completion a Provisional Order granting the necessary powers may be made, which becomes operative when confirmed by Parliament.

The amount of compensation in cases of dispute is referred to an arbitrator who again issues notices on the parties, hears their evidence and makes his

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award. No additional compensation for the compulsory nature of the acquisition is mentioned in the Land Clauses Act, but 10 per cent. is invariably allowed by arbitrators on the value of the property as estimated by them. The other way of acquiring land compulsorily by means of an Act of Parliament is an expensive matter. The local authority first consults a parliamentary agent who presents their petition in a proper form to Parliament. A Committee of Parliament inquires into the matter and local meetings of inhabitants have to be called. The Committee's recommendation is then submitted to Parliament for sanction. The procedure under the Town Planning Act does not strike one as being much simpler than that under the Land Clauses Act, but all the same it is considered by the English authorities as a great advance on the older method. Under the Town Planning Act (section 60), a local authority may be authorized to purchase any land required for the purposes of a scheme by means of an order submitted to and confirmed by the Local Government Board. The order, it should be noticed, is drawn up by the local authority, and not by the Local Government Board as under the Public Health Act. Before submitting the order to the Local Government Board the local authority publishes the order and issues notices to owners, lessees and occupiers, and any objections to the order have to be sent to the Local Government Board, who then cause a local inquiry to be held and may afterwards confirm the order with or without modifications. In rural districts the Board may appoint any person whom it thinks fit to hold an inquiry and their confirmation is final. In a borough or urban district an impartial person not in the employment of any Government department must hold the inquiry as to whether the land proposed to be acquired is suitable for the purposes for which it is sought to be acquired, and whether, having regard to the extent or situation of the land and the purposes for which it is used, the land can be acquired without undue detriment to the persons interested therein or the owners of adjoining land. If the result of inquiry is favourable to acquisition with or without conditions then the Local Government Board can confirm the order subject to the conditions, and such confirmation is final. If the Local Government Board does not accept the recommendations of the person who holds the inquiry then they can only provisionally confirm the local authority's order and this confirmation is subject to the sanction of Parliament.

When a town-planning scheme has been approved it is not easy to see how the suitability of any land for the purposes required, or any undue detriment to the persons interested therein or the owners of adjoining land, can be called in question. Objections on these points could have been made when the scheme was under preparation and should not be allowed to be again brought forward. If the order to acquire the land be not approved, apparently the local authority cannot obtain the land until they can come to terms with the owners, and in that case the execution of the scheme might be very materially delayed and its cost considerably enhanced.

It may be noted that the power to acquire land compulsorily under the Act can be granted at any time after a scheme has been approved, that is to say it may be given when the land is actually required for the purposes of the scheme, which may in some cases be several years after the date of approval.

Any question of disputed compensation is determined by a single arbitrator appointed by the Board and no additional allowance is made on account of the compulsory nature of the acquisition. The arbitrator acts as far as practicable in assessing compensation on his own knowledge and experience, and except when the Board otherwise directs is not allowed to hear counsel or expert witnesses.

IV.—Town Planning Act.

6. The English Town Planning Act has been stated to be the "least cast iron" piece of legislation imaginable. It certainly is very elastic and is a mere frame work upon which a town-planning scheme is drafted with provisions suitable to local requirements. The general object of a town-planning scheme is to secure proper sanitary conditions, amenity and convenience in connection with the laying-out and use of land which is in course of development or appears